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ABSTRACT

Science teacher education programs need to provide opportunities for teachers to acquire strategies of teaching which are compatible with the structure of what is to be taught. The use of more inductive/indirect teaching strategies, which reflect the true nature of science, seems to be dictated by the programs. Implementation of teacher training methods should be based upon empirical links of effectiveness which have been established between particular teacher behaviors and pupil outcomes and between a training mode and the desired teacher behavior. One classroom analysis system which has been designed to allow collection of data on teaching behaviors in both verbal and non-verbal classroom activities is the Teaching Strategy Observation Differential (TSOD). The TSOD is particularly well suited for collection of data on science teacher behavior in classrooms and laboratories where many of the learning activities involve student-centered non-verbal strategies. Another measure is the Data Processing Observation Guide which measures the occurrence of ten specific operations and three general interactions which occur in a classroom where science process skill learning is taking place. (BB)

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THE USE OF STRATEGY ANALYSIS TO TRAIN TEACHERS IN MANIPULATION OF TEACHING STRATEGIES

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Teaching strategies can be categorized on a continuum with extremes defined as expository/direct and inductive/indirect teaching. These extremes are represented by Anderson and Horn (1972) using the diagrams presented in Figures 1 and 2.

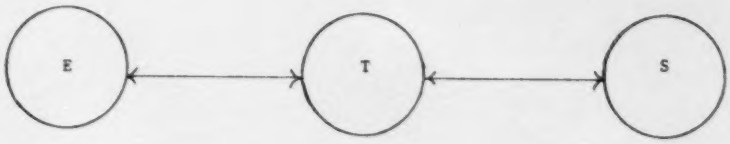

Figure 1. Conceptual model of expository/direct teaching.

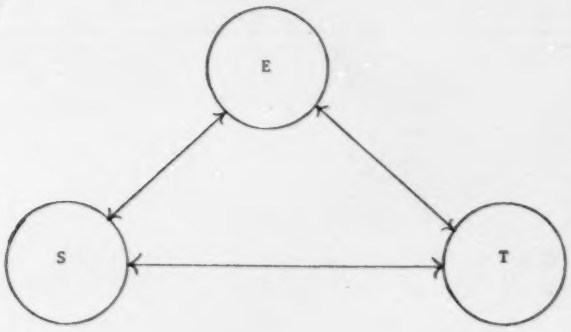

Figure 2. Conceptual model of inductive/indirect teaching.

The S represents student, T represents teacher, and E represents the classroom environment including the learning materials employed and the observable phenomena under study. These authors describe the expository/direct style as a strategy where the teacher acts as interpreter of natural phenomena for the students and is the "filter" through which all information is despensed. In the inductive/indirect style, the students interact directly with materials and formulate their own conclusions to

student generated questions; the teacher's role is largely that of facilitator and supplier of materials.

Science teacher education programs need to provide opportunities for teachers to acquire strategies of teaching which are compatible with the structure of what is to be taught. The modern science programs available to schools focus upon student use of materials and student inquiry. Accordingly, the use of more inductive/indirect teaching strategies, which reflect the true nature of science, seems to be dictated by the programs.

Schwab (1962) maintains that there is a need for a revolution in teaching and learning posture, with some of its contribution coming from those who train classroom teachers. If one accepts this position, it would seem that there is a mandate for pre-service training classes to encourage and train teachers in the use of inductive/indirect teaching strategies.

Student Achievement and Teaching Strategies

Research evidence suggests that there is a positive relationship between student achievement and attitudes and inductive/indirect teaching strategies. LaShier and Westmeyer (1967) found that eighth grade biology students in indirect classes achieved more and had better attitudes than students in direct classes. Schantz (1963) found that students learned more science in an indirect situation. Weber (1968) reported significant differences on three measures of verbal creativity indicating superior growth for pupils in indirect classrooms. Similar results were found in a study by Powell (1968). He concluded that growth in arithmetic scores was significantly higher for indirect classes. However, in the same study, Powell found that scores in reading were not significantly dif-

ferent for indirect and direct classes. Amidon and Flanders (1961) concluded that higher scores and a better attitude toward learning were associated with indirect geometry classes. In an experimental study, Shymansky and Matthews (1974) reported that a significant difference in student investigative skills resulted in classes taught by an indirect strategy. In summary, the research cited suggests that significant differences in achievement and attitude seem to favor indirect teaching strategies.

Based on the above research findings, it would seem pedagogically sound to make an attempt to analyze our teaching strategies and, if needed, adjust them to include more inductive/indirect interactions.

Analysis of Teacher Behavior

To analyze teaching strategies, one must ask if the behaviors that are related to higher student achievement can be identified by existing observational systems. If needed, can established behaviors be changed? If so, by what methods can the change be made in the desired direction?

Systematic observation of classroom instruction is not new. As early as 1914, Horn developed a system for observing and coding classrooms behavior. However, it has only been recently that systematic methods have become widely used. This greater emphasis on an empirical basis for our knowledge of classroom behavior is to be desired. For only by it can we subject the teaching act to some measure of analysis and control. Ivany and Neujahr (1970) state that to be able to assess something, one must first be able to describe it accurately and to know and undertand one's own behaviors leads to control of them.

Teacher Training and Empirical Links

Implementation of teacher training methods should be based upon empirical links of effectiveness which have been established between particular teacher behaviors and pupil outcomes and between a training mode and the desired teacher behavior.

Figure 3 represents a model of a process in which the training mode is selected because it influences a teaching behavior which is related to desired pupil outcomes. The model also shows that the desire to bring about a particular outcome or behavior should influence the selection of the teaching strategy or training mode.

The optimum condition is for the links to be established through experimental research and therefore be labeled as causal; but the state of the art may dictate that correlational links be accepted when causal links have not been explored and/or established.

Empirical Evidence for Teacher Training Mode

Current training in interaction analysis involves at least two aspects, both of which may affect the teaching behavior of the subjects. One aspect is training toward an awareness and understanding of the different levels of interaction. The second aspect would be modeling the lessons presented as examples of teaching strategy.

From a review of the literature related to the two areas mentioned above, the following conclusions are drawn:

1. Subjects that are exposed to a treatment involving verbal interaction analysis tend to move toward an indirect verbal teaching strategy. (e.g., Kirk and Amidon, 1967; Rousch and Kennedy, 1971; and Hough, Lohman and Ober, 1969.)

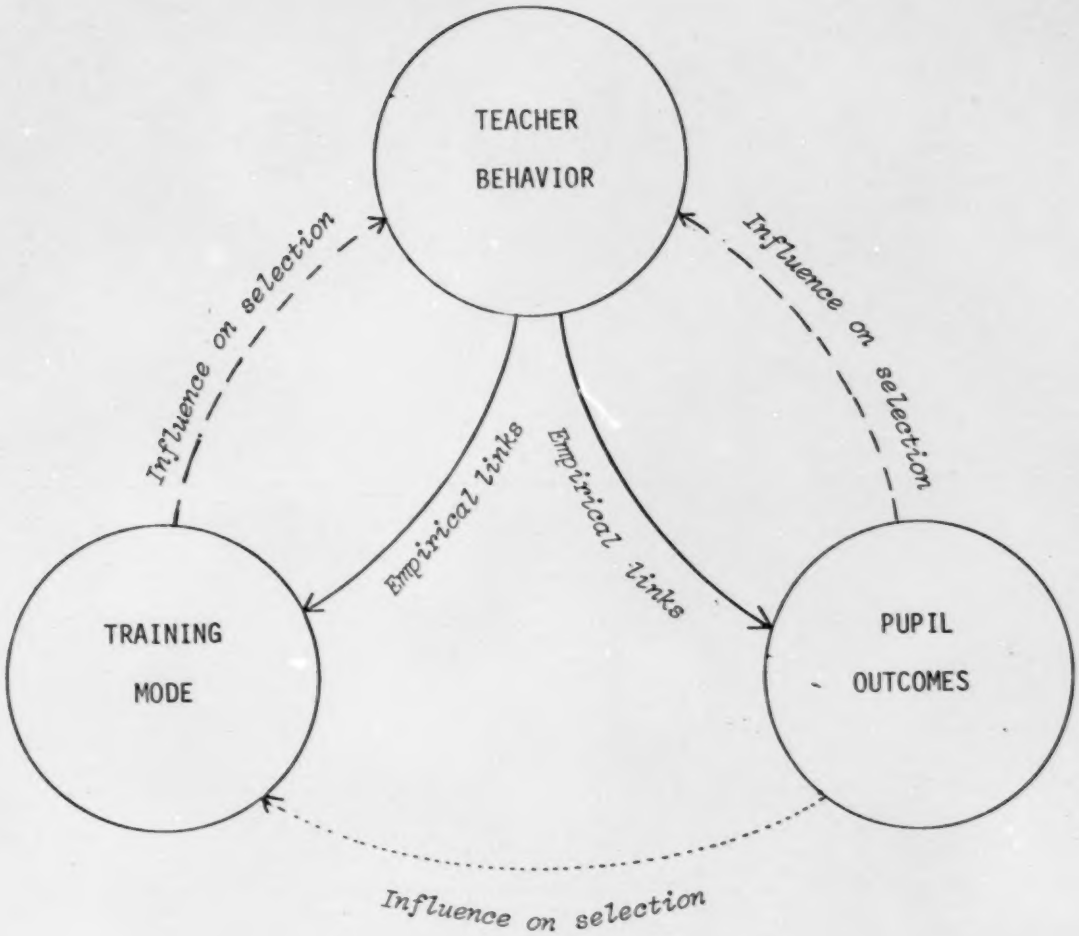

Figure 3. A process model for selecting training modes for teaching strategies related to desired pupil outcomes.

2. There is evidence that observational learning of indirect verbal strategy occurs when subjects receive video or audio stimulation from a model lesson using indirect strategy. (e.g., Bandura, 1965; Lange, 1971; and Zevin, 1973.)

The research cited provides evidence of empirical links between particular teaching strategies and pupil outcomes and between strategy analysis training modes and teacher behaviors. In fact, the links are strong and stable enough that they should be influencing the implementation of teacher training activities.

The Teaching Strategies Observation Differential

Many classroom analysis systems and observation differentials that have allowed us to describe and gain knowledge of teaching behaviors have been developed. Most of these are based on a few key assumptions -- namely that a teacher's verbal behavior adequately represents his total behavior, and therefore can be used singularly to measure classroom climate. This assumption has been questioned by several researchers. (e.g., Boyd and DeVault, 1966; Bales, 1950; Medley and Mitzel, 1958; Parakh, 1965, and Evans, 1968.) Most of the recent measures have been developed to collect data on both verbal and non-verbal classroom activities. One such measure is the Teaching Strategy Observation Differential (TSOD) developed by Anderson, Struthers and James (1974). The TSOD is particularly well suited for collecting data on science teacher behavior in classrooms and laboratories where many of the learning activities involve student-centered non-verbal strategies. The developers describe the function of the TSOD as systematically recording classroom activities. In doing so, the TSOD provides a measure of the overall teaching strategy or style used by a teacher,

including both the verbal and non-verbal interactions between teacher, students and the physical materials which constitute the classroom environment. This purpose is accomplished by providing a single rating of a teacher's style, representing his position on a continuum from 0-10 with extremes defined as expository/direct and inductive/indirect teaching.

The TSOD continuum on which the teaching strategy is rated is defined by Anderson, et al. (1974) using the following behavioral hierarchy:

I. NON-EDUCATIONAL ACTIVITIES

0_1 Non-educational activities beyond the teacher's control

0_2 Teacher controllable non-educational activities

II. DIRECT VERBAL

1. Facts
2. Direction or opinion
3. Limiting questions

III. DIRECT NON-VERBAL

4. Demonstration
5. Student exercises

IV. INDIRECT VERBAL

6. Teacher questions
7. Teacher response
8. Teacher guidance

V. INDIRECT NON-VERBAL

9. Teacher planned open ended investigations
10. Student planned investigations

Yeany (1977) reported a study in which the effects of training preservice elementary science teachers by strategy analysis using the TSOD, by the use of video-taped model lessons, and by a combination of the two

approaches were compared. The results of the study indicate that it is possible to significantly affect the teaching style and attitudes of preservice elementary science teachers. The best results were from the combined use of the TSOD and video-taped model lessons. However, use of either the TSOD or video-taped model lesson alone produced consistent trends along the same lines -- the subjects altered behavior toward more inductive/indirect teaching strategies.

Yeany (1978) further reported a study in which the use of microteaching combined with strategy analysis and videotaping on the teaching strategies of preservice science teachers was studied. The results of the study indicate that the use of the TSOD along with nonbiased interaction with an instructor after systematic analysis will cause a greater shift toward an inductive/indirect teaching strategy.

In a similar study, Riley (1978) utilized videotaped microteaching lessons, in which one group used the TSOD to rate a videotaped lesson they had taught, and another group used the TSOD to rate a videotaped lesson taught by a peer. A control group did not participate in any strategy analysis activities. The results of the study indicate that both experimental groups showed significant shifts toward inductive/indirect teaching strategies over the control group.

The Data Processing Observation Guide

Although the TSOD is useful in analyzing the broad behaviors of inductive/indirect strategies, there is a need to look at the more specific behaviors associated with science teaching. For example, the processes of science are of paramount importance to the discipline. These processes should also be of equal importance in the teaching of science and the new

science curricula are based on the premise that utilization of these processes will involve students in the scientific interprise. However, teacher trainers find it difficult to get teachers to use a science process oriented approach. In an effort to increase the facility of teachers to use such an approach, Yeany and Capie (1977) developed the Data Processing Observation Guide (DPOG). The DPOG describes and measures the occurence of ten specific operations and three general interactions which occur in a classroom where science process skill learning is taking place (see Figure 4).

The DPOG has two functions. First, it can be employed as a science teacher training tool where the trainer engages the teacher in systematic analysis of models (e.g., video tapes) of data processing behaviors. Potentially, this analysis can assist the teacher in identifying, communicating and designing data processing learning activities. The second function is to assess classroom behavior. In this function the DPOG serves as an assessment tool for research and program evaluation.

In a study of the effects of process skill analysis utilizing the DPOG, Yeany, Okey and Capie (1978) reported that pre-service secondary science teachers trained in the use of the DPOG were significantly influenced toward use of more student involvement in process skill teaching in lessons which involved data collection, manipulation, and interpretation.

A Suggestion Toward Implementation

Apparently teachers' verbal and non-verbal behaviors are influenced through the systematic analysis of both model and self-taught lessons. An efficient way to accomodate both of these influences is to engage the trainees in the analysis of selected teaching models while they are being

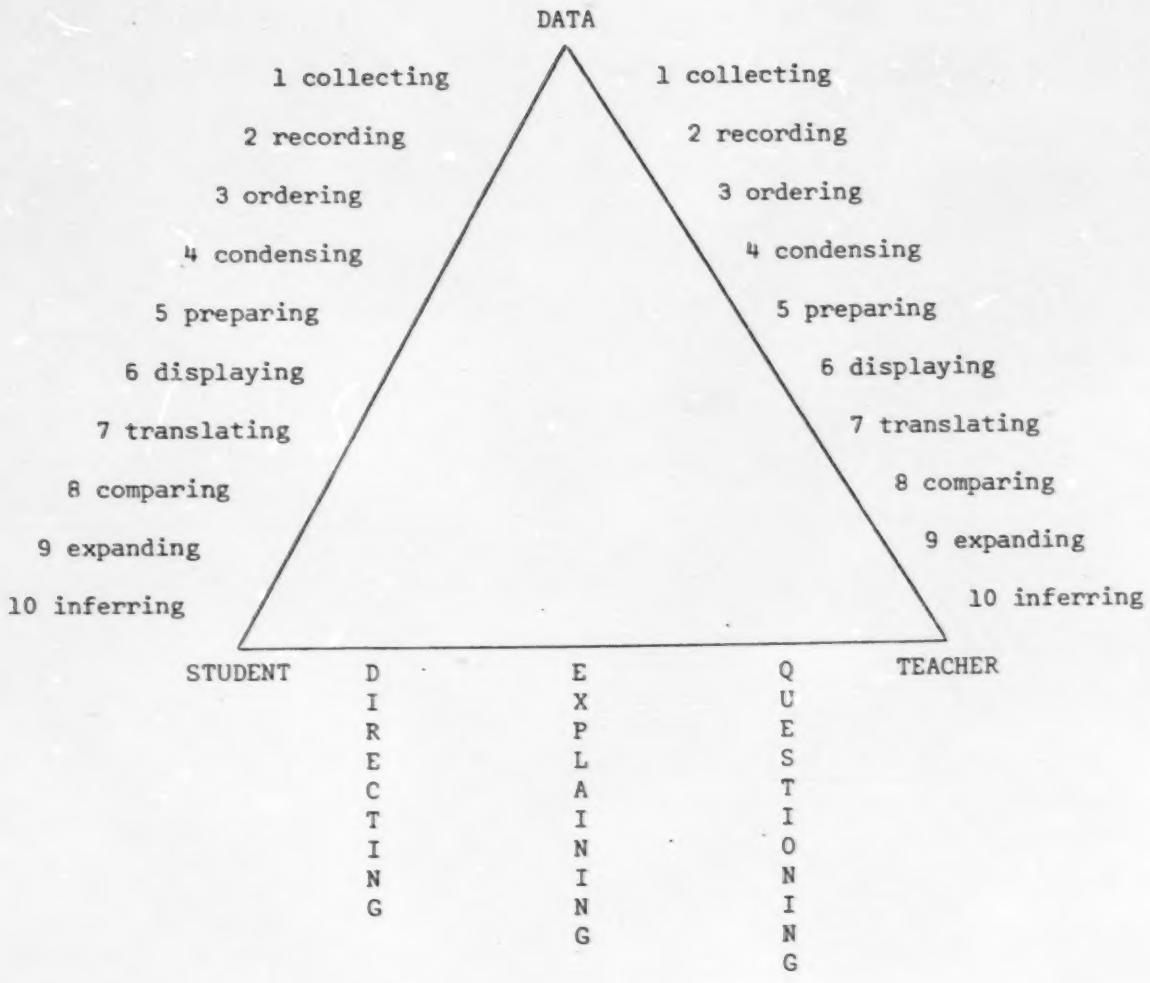

Figure 4. A model of operations and interactions that occur when students and teachers are working with data.

trained to use the analysis system and then assign them to employ the system as they observe recorded episodes of their own teaching. Also, as cited earlier, a guided analysis of their behaviors seems to maximize the influence of the strategy analysis sessions.

The Teaching Strategies Observation Differential has proven to be very effective when used in the above manner in the Secondary Science Teacher Training at the University of Georgia. In this program the trainees analyze videotaped model lessons which have been developed to present a full range of science teaching strategies which show evidence of being effective in bringing about desired pupil outcomes. The models vary from real teachers teaching in their own classes through professors conducting demonstration lessons in public schools to graduate students teaching contrived lessons to peers who are cooperating to produce a model lesson with selected characteristics.

During the systematic analysis of the model the tape is stopped frequently to determine the level of agreement on the TSOD coding of the classroom behaviors and to discuss the appropriateness and effectiveness of a particular strategy. After the entire lesson has been coded, the strategy profile of the lesson is mapped (see Figure 5) and the average level of directness/indirectness is calculated by summing all of the codings and dividing by the number of intervals coded. For example, an average coding of 1.7 indicates that the lesson has been very direct and teacher-centered while an 8.7 indicates an indirect student-centered lesson and 4.9 is near the middle of the continuum. This value should be combined with the strategy profile for a more complete interpretation. Each of these lesson parameters is then discussed in relation to their appropriateness and ease of executing in the science classroom.

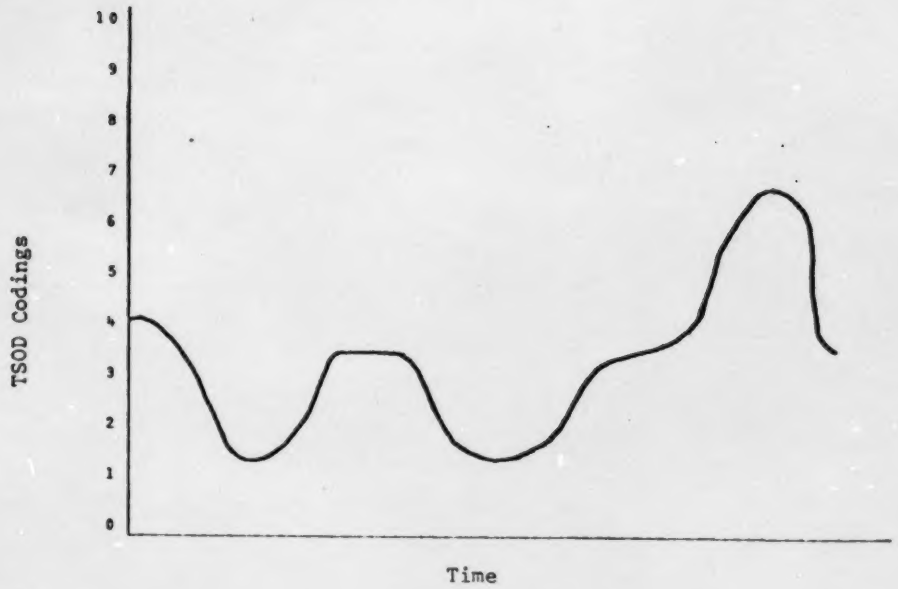

Figure 5. TSOD codings which have been graphed to represent a strategy profile for a single lesson.

When the trainees become proficient in identifying and coding teaching strategies, they are required to peer-teach a lesson designed to bring about selected outcomes by engaging in appropriate teacher/pupil behaviors. This lesson is video-recorded and saved for self-analysis by the student. After the self-analysis, the trainees have been required to teach and analyze a second lesson but a recent study indicates that this may have limited impact on the behavior changes (Yeany, Okey, & Capie, 1977). The big adjustments appear to be made during the model analysis and the first lesson.

The Data Processing Observation Guide (DPOG) is used with the same training protocal. After the viewing and analysis of models, the trainees are advised to teach lessons involving data collection, manipulation, and interpretation. They then use the DPOG to analyze the specific process skill teaching behaviors in these lessons.

The peer-teaching with video-taping offers the additional benefits of providing an opportunity for the trainees to experience the teaching act (often for the first time) in a controlled environment where the risks are minimal and to observe themselves and make adjustments before they are forced to integrate the almost infinite set of variables in the public school classroom. One should question whether the newly adopted teaching behaviors carry into the real classroom. Apparently they do. Results from the study by Yeany (1976) indicated that the behaviors were persisting several months later in the public school classrooms after the teachers had been trained in a university based program.

The above training protocol meets three important criteria which should be set for all teacher training activities. First, there is an established link between the teaching behaviors being acquired and resulting pupil outcomes. Second, there is empirical evidence that the training mode can bring about the desired behaviors, and, third, the protocol is feasible within most teacher training programs. These three conditions give support for recommending the use of systematic analysis of model and self-taught lessons as a means of influencing teachers' behaviors. And, as stated earlier, they should also be the conditions we look for in all of our teacher training activities.

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